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Disparity in psychological vulnerability: The relationship between wealth and emotional well-being before, during, versus after the nationwide COVID-19 outbreak in China

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Disparity in psychological vulnerability: The relationship between wealth and emotional well-being before, during, versus after the nationwide COVID-19 outbreak in China

Abstract

Objectives

This research investigated whether certain population segments (those with a lower income, those with fewer possessions) might be more psychologically vulnerable to the COVID-19 pandemic. This research also examined how disparities in wealth might be associated with differences in people's ability to restore their emotional well-being after a nationwide coronavirus outbreak ended and the economy reopened.

Setting, participants, and outcome measures

In this large-scale cross-sectional study, three waves of nationally-representative data collection (N = 27,760) were conducted immediately before (December 2019), in the midst of (February 2020), versus immediately after (April 2020) the countrywide COVID-19 outbreak in China. Respondents' emotional well-being, wealth (income, property ownership), and demographic information were measured using established instruments. Statistical analyses examined relationships between disparities in different types of wealth and disparities in emotional well-being.

Results

Although the coronavirus outbreak substantially degraded emotional well-being, having a higher income was associated with better emotional well-being during the outbreak. Property owners experienced a larger drop in emotional well-being during the outbreak than non-property owners; however, the former group was not emotionally worse off than the latter group. After the nationwide epidemic ended and the economy reopened, those with more wealth of either type again became better off in emotional well-being than those with less. The highest income segment even experienced better emotional well-being after the epidemic than before it. In contrast, the lowest income segment became worse off in emotional well-being after the end of the nationwide epidemic than prior to the outbreak.

Conclusion

People with less wealth are more susceptible to degradation in emotional well-being throughout the different phases of a pandemic. Pandemic health policies and programs are needed to help people, especially those who are more psychologically vulnerable, restore and maintain their mental well-being.

Strengths and limitations of this study

- Using large-scale, nationally-representative datasets, this research examined the relationships between wealth and psychological well-being before, during, and after the nationwide COVID-19 outbreak in China.
- This research identified segments in general population (those with a lower income or fewer possessions) that were more psychologically vulnerable to the onset of the nationwide outbreak.
- This research also uncovered that wealth differences were associated with exacerbated disparity in emotional well-being after the nationwide COVID-19 outbreak ended and the economy began to reopen. The highest income segment experienced better emotional well-being after the epidemic than before it. In contrast, the lowest income segment became worse off in emotional well-being after the end of the nationwide epidemic than prior to the outbreak.
- This research focused on individuals residing in China. This scope of investigation might limit the extent to which the findings are generalizable to residents of other countries.
- The post-nationwide-outbreak data collection round was conducted right after the economy had reopened. However, there were still sporadic cases in China. Thus, the longer-term, psychological implications of experiencing a nationwide disease outbreak may require further exploration.

1. Introduction

In recent decades, people around the world have been impacted by waves of disease outbreaks including COVID-19, Ebola, H1N1, SARS, MERS, and Zika. Due to the ever growing exploitation of the natural environment and increasing global travel and commerce, pandemics are anticipated to occur at an accelerated pace.[1-3] One of the societal-level consequences of pandemics is the degradation of people's emotional well-being.[4] However, relatively little is known about how people differ in psychological vulnerability to a pandemic outbreak and even less is known about how people differ in their ability to restore emotional well-being after the pandemic. The current research seeks to help fill these gaps in the literature by investigating how disparities in wealth may be associated with disparities in emotional well-being before, during, versus after the nationwide COVID-19 outbreak in China.

Prior research shows that wealth can influence emotional well-being in non-pandemic contexts,[5-7] and wealth can influence physical health and objective well-being during the pandemic.[8-9] We complement this research stream by examining the relationship between wealth and emotional-welling throughout the different phases of a pandemic, and by investigating the psychological implications of disparities in income and property ownership. These two types of wealth have been established, respectively, as an indirect and direct indicator of wealth.[10] More importantly, the two types of wealth differ in convertibility: Income can be quickly converted into other types of resources, whereas property ownership cannot be converted into other types of resources as easily and quickly. Hence, examining the two wealth types can inform the understanding of how disparities in wealth may influence psychological well-being.

2. Methods

Patient and Public Involvement. Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Our datasets came from three large-scale, nationally-representative surveys conducted before, during, versus after the countrywide COVID-19 outbreak in China. The first round of data collection (N = 11,131; from 32 provincial regions; 48% women; average age of 37.78; 66% married) was conducted at the end of December 2019 (immediately before the outbreak was publically reported in China). The second (N = 3,000; from 30 provincial regions; 50% women; average age of 34.7; 69% married) was in mid-February 2020 (during the nationwide outbreak). The third (N = 13,629; from 32 provincial regions; 49% women; average age of 37.47; 60% married) was in early April 2020 (immediately after the nationwide outbreak ended and the economy was reopened in China).

Participants in all three surveys responded to an established measure of emotional well-being.[6] Specifically, they indicated whether they smiled or laughed a lot yesterday, and whether they experienced a lot of enjoyment / happiness / anger / sadness / stress / worry yesterday (1 = yes, 0 = no). Participants also completed two measures pertaining to their wealth – monthly household income (in Renminbi [RMB]) and property ownership (1 = own a property, 0 = do not own). For

demographic variables, participants indicated their age, sex (1 = female, 0 = male), marital status (1 = married, 0 = not married), and residence region.

Following an established approach,[11] we constructed an index of emotional well-being by subtracting the average of the negative emotions experienced from the average of the positive emotions experienced. This overall index served as the dependent variable in our analyses. Also, following a prior approach,[4] we normalized the household income measure and linearly transformed the value by dividing it by 10,000 so that the monthly income is measured in units of RMB 10,000. Finally, we coded whether participants were residing in Hubei (1 = yes, 0 = no), the province where the overwhelming majority of confirmed coronavirus infection cases and deaths occurred in China.[12]

We created two time period dummy variables representing the "during the outbreak" and "after the outbreak" periods, respectively. Hence, the period before the outbreak was represented by zero values on the two dummies, and this period served as the baseline against which the other two periods were compared. We ran a series of regressions with emotional well-being as the dependent variable (table 1). The two time period dummies, income and property ownership, as well as the interaction terms between two dummies and the wealth measures were the predictors. The demographic variables – residing in Hubei, age, sex, and marital status – were also included as control variables. This series of models allowed us to assess the robustness of the significant co-efficient estimates.

3. Results

The during-outbreak dummy exhibited a significant negative effect across all models ($-.32 \leq \beta \leq -.17$, $.01 \leq SE \leq .04$, $p < .001$), indicating that people's overall emotional well-being substantially worsened when the nationwide coronavirus outbreak began (table 1). The after-outbreak dummy also consistently exhibited a significant negative effect ($-.08 \leq \beta \leq -.05$, $.01 \leq SE \leq .02$, $p < .05$), indicating that even after the nationwide outbreak ended and the economy started to reopen, people's emotional well-being, on average, did not fully recover to the levels before the outbreak. Further, both types of wealth had consistent, significant positive effects ($.01 \leq \beta \leq .02$, $.002 \leq SE \leq .004$, $p < .001$ for income; $.20 \leq \beta \leq .22$, $.01 \leq SE \leq .02$, $p < .001$ for property ownership). That is, disparities in wealth were associated with disparities in emotional well-being—having a higher income or owning more properties was associated with a higher level of emotional well-being.

More importantly, income level did not have a significant interaction with the during-outbreak dummy ($-.014 \leq \beta \leq -.007$, $SE = .01$, $p > .20$), indicating that the nationwide epidemic led to a parallel drop of emotional well-being across high versus low income groups (figure 1). However, a consistent, significant negative real estate ownership × during-outbreak interaction emerged ($-.17 \leq \beta \leq -.16$, $SE = .04$, $p < .001$; figure 2). We conducted a series of contrasts to further dissect this interaction: Although property owners experienced significantly better emotional well-being than non-owners before the outbreak ($M_{owner} = .47$, $SE_{owner} = .01$ vs. $M_{non\text{-}owner} = .25$, $SE_{non\text{-}owner} = .01$; $F(5, 26638) = 203.18$, $p < .0001$, $d = .17$), the former group was directionally (but not significantly) better in emotional well-being than the latter group during the outbreak ($M_{owner} =$

.12, SE_{owner} = .01 vs. $M_{non\text{-}owner}$ = .07, $SE_{non\text{-}owner}$ = .03; $F(5, 26638) = 2.58$, $p = .11$, d = .02; figure 2).

Moreover, property ownership did not interact with the after-outbreak dummy ($.001 \leq \beta \leq .018$, SE = .02, $p > .36$), indicating that, after the nationwide epidemic ended, property owners again became better off in emotional well-being than non-owners. A consistent, significant positive income × after-outbreak interaction was found ($.014 \leq \beta \leq .017$, SE = .005, $p < .01$), indicating that having a higher income exhibited an even more positive effect on emotional well-being after the end of the nationwide outbreak than before the outbreak began. A Johnson-Neyman analysis (figure 3) was conducted to further dissect this interaction. This analytical technique[13] has been widely used to determine regions of significance in interaction effects. In the current research context, we used a Johnson-Neyman analysis to assess the specific income regions where emotional well-being significantly differed before versus after the pandemic. This analysis showed that the highest income segment experienced even better emotional well-being after the outbreak ended than prior to the outbreak. In stark contrast, the lowest income segment experienced significantly lower emotional well-being after the end of the nationwide epidemic than before the outbreak began.

4. Discussion

Our research findings add to the understanding of how disparities in wealth may be associated with disparities in psychological well-being during different phases of a disease outbreak. Specifically, our findings suggest that before the onset of a pandemic, having a higher income or owning more properties can predict a higher level of emotional well-being. A pandemic outbreak can substantially degrade emotional well-being regardless of the types of wealth one possesses. However, the positive effect of having a higher income on emotional well-being can persist during the outbreak. In contrast, owning more properties may not yield the same advantage. These differences in the relationship between emotional well-being and income versus property ownership can potentially be attributed to the differences in their convertibility into other resources. The onset of the COVID-19 pandemic compelled people to immediately seek (and even stockpile) many categories of goods, ranging from food and medicine to paper towels and toilet papers, from masks and disinfectants to security cameras and firearms.[14] Because of its high convertibility, having more "liquid" wealth such as a higher income can enable individuals to more quickly obtain these resources. This can potentially provide a sense of control, which has been shown to attenuate the detrimental impact of a pandemic on emotional well-being.[4] In contrast, having more "illiquid" wealth such as real estate cannot offer the same level of resource convertibility and thus may not help protect against the emotional blow of the pandemic to the same degree. The low convertibility (e.g., difficulties associated with selling real estate during the pandemic, particularly at normal price levels) may even lead to frustration, hampering emotional well-being.

Our findings also suggest that shortly after a pandemic, having either a higher income or owning more properties can again predict a higher level of emotional well-being. The highest income segment may even experience better emotional well-being after the outbreak ends than prior to it. However, the opposite may be true for the lowest income segment. This pattern can potentially

be attributed to that people at the highest income levels were able to immediately engage in more happiness-boosting activities than before, whereas those at the lowest income levels had to curtail their non-essential, hedonic consumption activities.[15] Overall, these results add to the literature on the impact of disease outbreaks on psychological well-being and highlight how disparities in wealth can be linked to disparities in mental health. Our findings also inform health policies, programs and interventions aimed at caring for people's emotional well-being (especially that of the most psychologically vulnerable groups) in the age of pandemics.

Competing interests
The authors declare no conflicts of interest.

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Contributors
JM obtained the datasets. HY and JM designed the research, analyzed the data, and wrote the manuscript.

Ethics approval
The data collection in this research received approval from the National School of Development at Peking University.

Data availability statement
The data used in this research can be available from the corresponding author upon request.

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Table 1. The relationship between different types of wealth and emotional well-being before, during, versus after the nationwide COVID-19 outbreak in China.

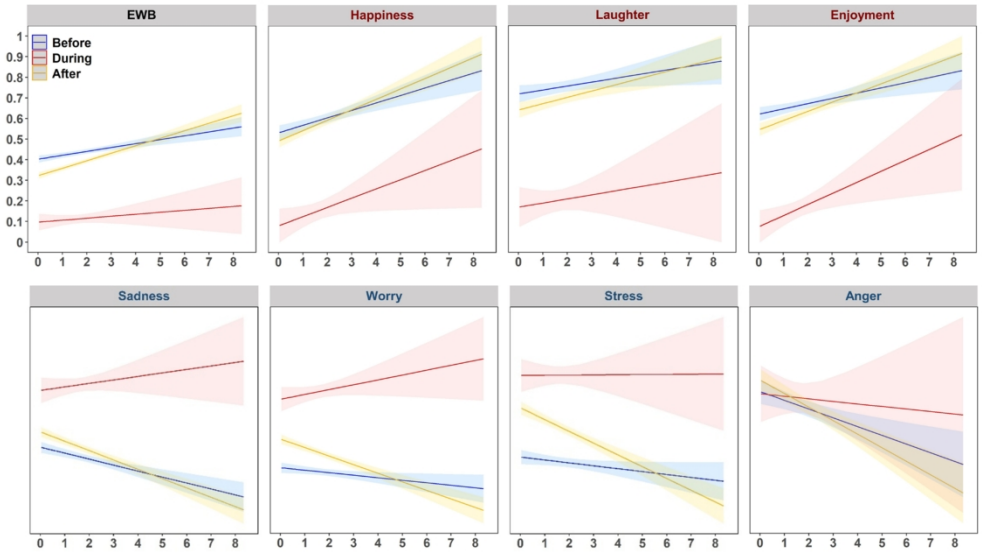
Emotional Well-being							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
During	-.323****	-.301****	-.303****	-.182****	-.180****	-.170****	-.171****
	(.012)	(.022)	(.021)	(.035)	(.035)	(.037)	(.037)
After	-.052****	-.080****	-.065****	-.054***	-.046*	-.064***	-.064***
	(.008)	(.012)	(.012)	(.018)	(.019)	(.020)	(.020)
Income		.019****	.013****		.019****	.013****	.012****
		(.004)	(.004)		(.002)	(.004)	(.004)
Income × During		-.011	-.014			-.007	-.008
		(.011)	(.011)			(.011)	(.011)
Income × After		.017****	.014***			.014**	.014***
		(.005)	(.005)			(.005)	(.005)
Real Estate Ownership			.195****	.220****	.206****	.216****	.210****
			(.010)	(.015)	(.016)	(.016)	(.016)
Real Estate Ownership × During				-.166****	-.163****	-.165****	-.161****
				(.037)	(.037)	(.037)	(.037)
Real Estate Ownership × After				.018	.010	.001	.0006
				(.020)	(.021)	(.021)	(.021)
Hubei			-.007		-.004		-.005
			(.017)		(.017)		(.017)
Age			.0004		.0004		.0004
			(.0003)		(.0003)		(.0003)
Sex			.005		.005		.005
			(.007)		(.007)		(.007)
Married			.007		.006		.006
			(.010)		(.010)		(.010)
Constant	.437****	.403****	.224****	.249****	.206****	.229****	.215****
	(.005)	(.009)	(.015)	(.014)	(.018)	(.015)	(.018)

Notes: * $p \leq .05$; ** $p \leq .01$; *** $p \leq .005$; **** $p \leq .001$
Standard errors are shown in parentheses below coefficient estimates.
Dummy variable coding: During (1 = during the nationwide COVID outbreak, 0 = other time period), After (1 = after the nationwide COVID outbreak ended and the economy reopened, 0 = other time period), Real Estate Ownership (1 = owner, 0 = non-owner), Hubei (1 = in Hubei, 0 = not in Hubei), Sex (1 = female, 0 = male), and Married (1 = married, 0 = not married). (Zero values on the During and After dummies represented the before pandemic condition, which served as the reference group in the analyses.)

Figure 1. The relationship between income and emotional well-being before, during, versus after the nationwide COVID-19 outbreak. X-axis represents household income (in RMB 10,000 increments). Y-axis represents Emotional Well-Being (a composite index of Happiness, Smile/Laughter, Enjoyment, Sadness, Worry, Stress, & Anger, which are also shown separately). Blue line represents the period before the nationwide coronavirus outbreak; red line, during the outbreak; yellow line, after the nationwide outbreak. Shaded areas represent the 95% CI for the respective lines.

Figure 2. The relationship between real estate ownership and emotional well-being before, during, versus after the nationwide COVID-19 outbreak. X-axis represents the three time periods: before, during, versus after the nationwide coronavirus outbreak. Y-axis represents Emotional Well-Being (a composite index of Happiness, Smile/Laughter, Enjoyment, Sadness, Worry, Stress, & Anger, which are also shown separately). Orange line represents property owners; gray line, non-owners.

Figure 3. The relationship between income and emotional well-being before versus after the nationwide COVID-19 outbreak. X-axis represents household income (in RMB 10,000 increments). Y-axis represents experienced Emotional Well-Being (a composite index of Happiness, Smile/Laughter, Enjoyment, Sadness, Worry, Stress, & Anger). Blue line represents the period before the nationwide coronavirus outbreak; yellow line, after the nationwide outbreak. Shaded areas represent the 95% CI for the respective lines. The gray area represents the Johnson–Neyman regions of significance. The area between the two dashed lines represent the region of non-significance. Specifically, those with a monthly household income higher than RMB 78,100 (as indicated by the dash line on the right) experienced significantly more happiness after the outbreak ended than prior to the outbreak. In contrast, those with a monthly household income lower than RMB 34,000 (as indicated by the dash line on the left) experienced significantly less happiness after the end of the nationwide epidemic than before outbreak began.



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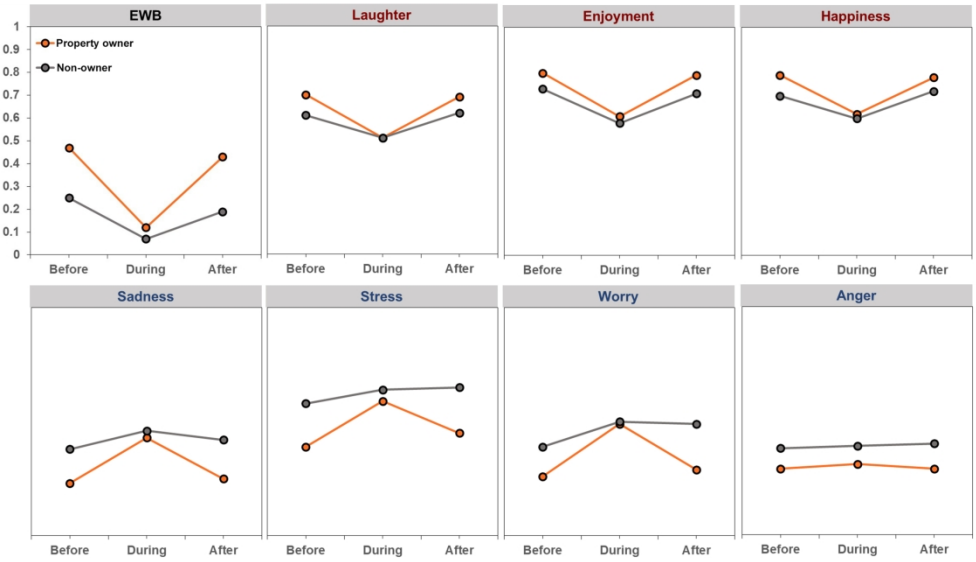

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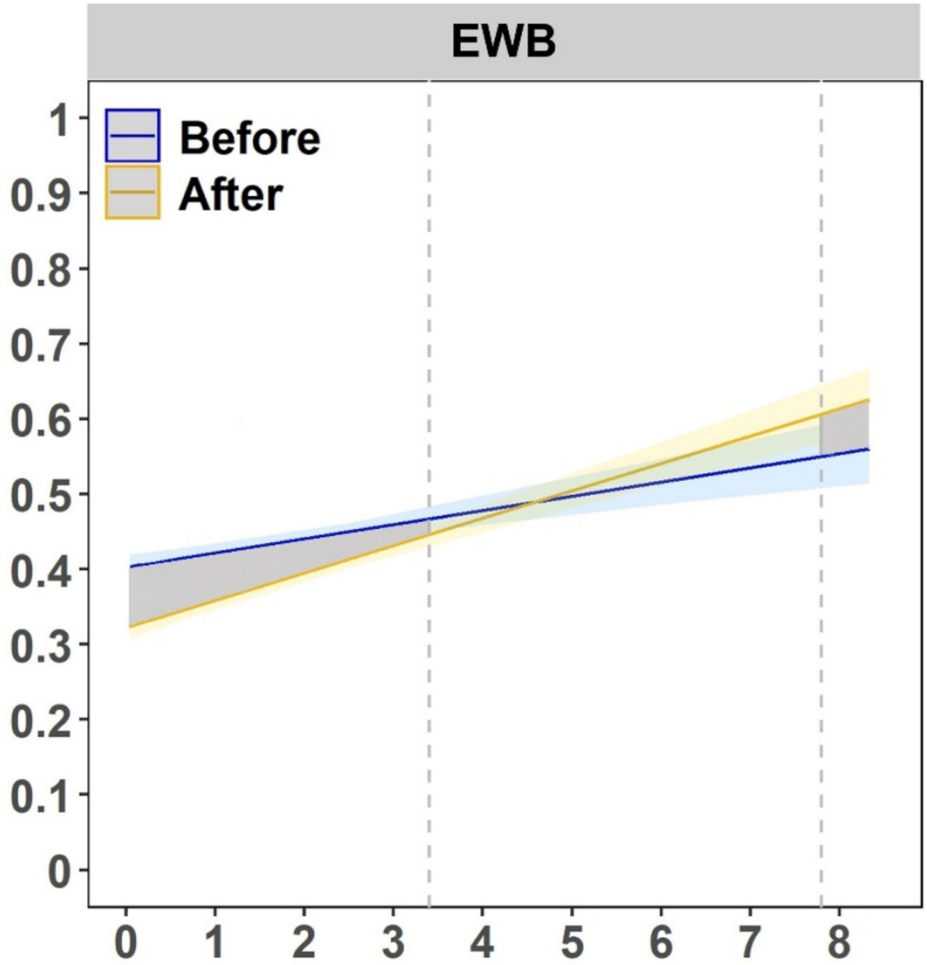

Figure 3. The relationship between income and emotional well-being before versus after the nationwide COVID-19 outbreak. X-axis represents household income (in RMB 10,000 increments). Y-axis represents experienced Emotional Well-Being (a composite index of Happiness, Smile/Laughter, Enjoyment, Sadness, Worry, Stress, & Anger). Blue line represents the period before the nationwide coronavirus outbreak; yellow line, after the nationwide outbreak. Shaded areas represent the 95% CI for the respective lines. The gray area represents the Johnson–Neyman regions of significance. The area between the two dashed lines represent the region of non-significance. Specifically, those with a monthly household income higher than RMB 78,100 (as indicated by the dash line on the right) experienced significantly more happiness after the outbreak ended than prior to the outbreak. In contrast, those with a monthly household income lower than RMB 34,000 (as indicated by the dash line on the left) experienced significantly less happiness after the end of the nationwide epidemic than before outbreak began.

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The relationship between wealth and emotional well-being before, during, versus after a nationwide disease outbreak: A large-scale investigation of disparities in psychological vulnerability across COVID-19 pandemic phases in China

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Abstract

Objectives

This research investigated whether certain population segments might be more psychologically vulnerable in different phases of a pandemic. Specifically, this research examined how disparities in wealth might be associated with differences in emotional well-being before, during, versus after the nationwide COVID-19 outbreak in China.

Setting, participants, and outcome measures

In this large-scale cross-sectional study, three rounds of nationally-representative data collection (N=27,760) were conducted immediately before (December 2019), in the midst of (February 2020), versus immediately after (April 2020) the countrywide COVID-19 outbreak in China. Participants' emotional well-being, wealth (income, property ownership), and demographic information were measured using established instruments. Statistical analyses examined relationships between disparities in different types of wealth and emotional well-being across the pandemic phases.

Results

Although the onset of the coronavirus outbreak substantially degraded emotional well-being, having a higher income was associated with better emotional well-being during the outbreak. Real estate owners experienced a larger drop in emotional well-being during the outbreak than non-owners; however, the former was not emotionally worse off than the latter during the outbreak. After the nationwide COVID-19 outbreak had been contained and the economy reopened, those with more wealth of either type again became better off in emotional well-being than those with less. The highest income segment even experienced better emotional well-being after the end of the nationwide outbreak than prior to the outbreak. In contrast, the lowest income segment became worse off in emotional well-being after the nationwide outbreak ended than before the outbreak began.

Conclusion

People with less wealth tend to be emotionally worse off throughout the different phases of a disease outbreak. In particular, even after an outbreak has been contained, the poor are less able to restore their psychological well-being. Policies and interventions are needed to address disparities in mental health in the age of pandemics.

Strengths and limitations

- This research used large-scale nationally-representative datasets to examine the psychological impacts of a contagious disease outbreak.
- The relationship between wealth and emotional well-being was investigated across pandemic phases – before, during, versus after the nationwide COVID-19 outbreak in China.
- Overall emotional well-being, positive emotion, and negative emotion indexes were each analyzed to dissect the psychological patterns.
- This research focused on individuals residing in China, and hence the extent to which the findings are generalizable to residents of other countries requires further investigation.
- The longer-term (e.g., after the complete eradication of COVID-19) psychological implications of experiencing a nationwide disease outbreak require further research.

1. Introduction

In recent decades, people around the world have been impacted by many major disease outbreaks including COVID-19, Ebola, H1N1, SARS, MERS, and Zika. Due to the ever growing exploitation of the natural environment and increasing global travel and commerce, pandemics are anticipated to occur at an accelerated pace.[1-3] One of the societal-level consequences of pandemics is the degradation of people's emotional well-being.[4] However, relatively little is known about the extent to which people may be psychological vulnerable to the different phases of a pandemic. Even less is known about which population segments might be less able to maintain their psychological well-being across disease outbreak phases. The current research seeks to help fill these gaps in the literature by investigating how disparities in wealth may be associated with disparities in emotional well-being before, during, versus after the nationwide COVID-19 outbreak in China.

Prior research shows that wealth can influence emotional well-being in non-pandemic contexts,[5-7] and that wealth can influence physical health and objective well-being during a pandemic.[8-9] We complement this research stream by examining the relationship between wealth and emotional-welling across pandemic phases, and by investigating the psychological implications of disparities in income and property ownership. These two types of wealth have been established, respectively, as an indirect and direct indicator of wealth.[10] More importantly, the two types of wealth differ in convertibility: Income can be converted into other types of resources relatively quickly, whereas property ownership cannot be converted into other types of resources as easily and quickly. Hence, examining the two wealth types can inform the understanding of how disparities in wealth may influence psychological well-being.

2. Methods

Our datasets came from three large-scale nationally-representative, cross-sectional surveys conducted before, during, versus after the countrywide COVID-19 outbreak in China. An identical sampling method was used in all three data collection rounds. The first was carried out immediately before coronavirus infections were publicly reported in China (late December, 2019; N = 11,131; 48% women; 66% married; average age of 37.78; residing in 32 provincial regions). The second was conducted during the peak of the pandemic in China (mid-February, 2020; N = 3,000; 50% women; 69% married; average age of 34.7; residing in 30 provincial regions). The third was conducted immediately after the nationwide outbreak had been contained and the economy reopened in China (early April, 2020; N = 13,629; 49% women; 60% married; average age of 37.47; residing in 32 provincial regions). In each survey, participants were asked to respond to an established scale of emotional well-being[6]. Specifically, they indicated whether or not they experienced different positive (i.e., smile/laughter, enjoyment, happiness) and negative emotions (i.e., anger, sadness, stress, worry) yesterday (1 = experienced, 0 = did not). Participants also completed two measures pertaining to their wealth – monthly household income (in Renminbi [RMB]) and real estate ownership (1 = own a property, 0 = do not own). For demographic variables, participants indicated their age, sex (1 = female, 0 = male), marital status (1 = married, 0 = not married), and residence region.

To analyze the data, we conducted Chi-squared tests on whether the percentage of individuals experiencing each of the emotions differed across the three pandemic phases. We also conducted a series of regressions to investigate the relationship between wealth and emotional well-being across the phases. Specifically, we constructed an index of positive emotions (with a value range of 0 - 1) by taking the average of the positive emotion measures, as well as an index of negative emotions (with a value range of 0 - 1) by averaging the negative emotion measures. Following an established approach,[11] we also constructed an index of overall emotional well-being by subtracting the negative emotion index from the positive emotion index. This overall index (with a value range of 0 - 1) thus accounted for experiences of both positive and negative emotions. These three indexes served as the dependent variables in our analyses. Also, following a prior approach,[4] we normalized the household income measure and linearly transformed the value by dividing it by 10,000 so that the monthly income is measured in units of RMB 10,000. Finally, we coded whether participants were residing in Hubei (1 = yes, 0 = no), the province where the first Chinese cases of COVID-19 were reported.[12]

We created two time-period dummy variables representing the "during the outbreak" and "after the outbreak" periods, respectively. Hence, the period before the outbreak was represented by zero values on the two dummies, and this period served as the baseline against which the other two periods were compared. We conducted three sets of regression analyses using different dependent variables: overall emotional well-being index, positive emotion index, and negative emotion index. In each set of analyses, the two time period dummies, income and real estate ownership, as well as the interaction terms between the two dummies and the wealth measures were the predictors of interests. The demographic variables – residing in Hubei, age, sex, and marital status – were included as control variables. The series of models we ran helped assess the robustness of the significant co-efficient estimates.

3. Results

3.1. Distribution of emotions

A series of Chi-squared analyses showed that, with the exception of anger, all other emotions differed significantly across the three pandemic phases (see tables 1a and 1b for distributions): As compared to before or after the nationwide outbreak, fewer individuals experienced positive emotions during the outbreak. Conversely, more individuals experienced negative emotions during the outbreak than before or after it.

3.2. Emotional well-being

3.2.1. Pandemic phases

As shown in tables 2-4, we ran three sets of regression analyses with the overall emotional well-being index, positive emotion index, and negative emotion index as the dependent variable, respectively. The during-outbreak dummy exhibited a significant effect on overall emotional well-being across all models, indicating that people's psychological well-being substantially worsened when the nationwide coronavirus outbreak began. Further, this dummy also exhibited a consistent significant effect on the positive emotion index as well as on the negative emotion index. That is, people experienced fewer positive emotions and more negative emotions during nationwide coronavirus outbreak than prior to the outbreak.

The after-outbreak dummy exhibited a consistent significant effect on overall emotional well-being, indicating that even after the nationwide outbreak had been contained and the economy reopened, people's emotional well-being, on average, did not fully recover to the levels before the outbreak. This dummy exhibited a significant effect on the positive emotion index in Models 1-3 but not in Models 4-7. However, the dummy exhibited a consistent significant effect on the negative emotion index, indicating that even after the nationwide outbreak had been contained, people, on average, still experienced more negative emotions than before the outbreak.

3.2.2. Wealth

Both types of wealth had consistent significant effects on overall emotional well-being. That is, disparities in wealth were associated with disparities in emotional well-being – having a higher income or owning (vs. not owning) real estate was associated with a higher level of emotional well-being. Analyses using the positive and negative emotion indexes showed that having more of either type of wealth was associated with experiences of more positive emotions and fewer negative ones.

3.2.3. Wealth × pandemic phase interactions

Income level did not interact with the during-outbreak dummy to impact overall emotional well-being. In other words, the nationwide outbreak led to a parallel drop of emotional well-being across high versus low income groups (figure 1). In analyses using the positive emotion index, this interaction was also not significant. In analyses using the negative emotion index, the interaction between income level and the during-outbreak dummy approached significance, indicating that higher income individuals experienced a larger increase in negative emotions when the pandemic began. However, as the analyses using the overall emotional well-being index suggest, at the aggregate level, the income × during-outbreak interaction was not significant.

A consistent significant real estate ownership × during-outbreak interaction effect on overall emotional well-being was found (figure 2). We conducted a series of contrasts to further dissect this interaction: Although real estate owners experienced significantly better emotional well-being than non-owners before the outbreak (M_{owner} = .47, SE_{owner} = .01 vs. $M_{non\text{-}owner}$ = .25, $SE_{non\text{-}owner}$ = .01; $F(1, 26638) = 203.18$, $p < .0001$, d = .17), the former group was only directionally (not significantly) better in emotional well-being than the latter group during the outbreak (M_{owner} = .12, SE_{owner} = .01 vs. $M_{non\text{-}owner}$ = .07, $SE_{non\text{-}owner}$ = .03; $F(1, 26638) = 2.58$, $p = .11$, d = .02). In analyses using the positive emotion index, real estate ownership significantly interacted with the during-outbreak dummy, indicating that, after the start of the pandemic, real estate owners experienced a larger decrease in positive emotions than non-owners. In analyses using the negative emotion index, real estate ownership also significantly interacted with the during-outbreak dummy, indicating that, after the start of the pandemic, real estate owners experienced a larger increase in negative emotions than non-owners. That is, the patterns of changes in the overall emotional well-being, positive and negative emotion indexes were consistent – despite experiencing a steeper drop in emotional well-being, real estate owners were still not worse off than non-owners.

A consistent significant income × after-outbreak interaction effect on overall emotional well-being was found, indicating that having a higher income exhibited an even more favorable effect on overall emotional well-being after the end of the nationwide outbreak than before the outbreak began. A Johnson-Neyman analysis (figure 3) was conducted to further dissect this interaction. This analytical technique[13] has been widely used to determine regions of significance in interaction effects. In the current research context, we used a Johnson-Neyman analysis to estimate the income regions where emotional well-being significantly differed before versus after the pandemic. This analysis showed that the highest income segment experienced even better emotional well-being after the outbreak had been contained than prior to the outbreak. In stark contrast, the lowest income segment experienced significantly lower emotional well-being after the end of the nationwide outbreak than before the outbreak began. Analyses using the positive emotion index showed that, in Models 2 and 7, there was a marginally significant income × after-outbreak interaction – higher income individuals experienced more positive emotions after the end of the nationwide outbreak than before the outbreak began. In analyses using the negative emotion index, a consistent significant interaction was found, suggesting that higher income individuals experienced fewer negative emotions after the end of the nationwide outbreak than before the outbreak began. That is, the differences in overall emotional well-being were largely consistent with the patterns of positive and negative emotions.

Moreover, real estate ownership did not interact with the after-outbreak dummy to impact overall emotional well-being. Analyses using the positive emotion index and negative emotion index also did not yield a significant real estate ownership × after-outbreak interaction. These results suggest that, after the nationwide COVID-19 outbreak had been contained, real estate owners again became better off in emotional well-being than non-owners.

3.2.4. Control variables

The co-efficient estimates for the control variables (residing in Hubei, age, sex, and marital status) were not significant in the analyses on overall emotional well-being. However, analyses using the positive emotion index showed that, during the timespan examined in this research, older people, on average, experienced significantly fewer positive emotions, whereas women (vs. men) and married (vs. not) individuals experienced significantly more positive emotions. Analyses using the negative emotion index revealed that older people experienced fewer negative emotions, whereas women and married individuals experienced more negative emotions. These patterns suggest that, during the timespan examined, older people were less emotional but women and married individuals were more emotional (in terms of experiencing emotions of both valences).

4. Discussion

Our research findings add to the understanding of how disparities in wealth may be associated with disparities in psychological well-being across the different phases of a disease outbreak. Specifically, our findings suggest that before the onset of a pandemic, having a higher income or owning more properties is associated with a higher level of emotional well-being. A pandemic outbreak can substantially degrade emotional well-being regardless of the types of wealth one possesses. However, the positive effect of having a higher income on emotional well-being can

persist during the outbreak. In contrast, owning more properties may not yield the same level of advantage. These differences in the relationship between emotional well-being and income versus property ownership may potentially be attributed to the differences in their convertibility into other resources. The onset of the COVID-19 pandemic compelled people to immediately seek (and even stockpile) many categories of goods, ranging from food and medicine to paper towels and toilet papers, from masks and disinfectants to security cameras and firearms.[14] Because of its high convertibility, having more "liquid" wealth such as a higher income can enable individuals to more quickly obtain these resources. This can potentially provide a sense of control, which may help attenuate the detrimental impact of a pandemic on emotional well-being.[4] In contrast, having more "illiquid" wealth such as real estate cannot offer the same level of resource convertibility and thus may not help protect against the emotional blow of the pandemic to the same degree.

Our findings also suggest that shortly after the end of a pandemic, having either a higher income or owning more properties can again predict a higher level of emotional well-being. The highest income segment may even experience better emotional well-being after versus before the pandemic. However, the opposite may be true for the lowest income segment. This pattern may potentially be attributed to that people at the highest income levels are able to immediately engage in more happiness-boosting/stress-reducing activities than before, whereas those at the lowest income levels have to curtail their non-essential, hedonic consumption activities.[15] Overall, these results add to the literature on how disease outbreaks impact mental health, illustrating the link between disparities in wealth and disparities in psychological well-being across disease outbreak phases. Our findings also inform policies, programs and interventions aimed at caring for people's emotional well-being, especially that of the most psychologically vulnerable groups, in the age of pandemics.

Finally, our findings suggest several directions for future research. First, our investigation focused on individuals residing in China. As countries may differ in factors such as economic development, culture, and pandemic related policies, the extent to which the findings are generalizable to residents of other countries requires further research. Second, the post-outbreak data collection round was conducted right after the nationwide COVID-19 outbreak had been contained in China and its economy reopened. However, there were sporadic cases occurring. Thus, the longer-term (e.g., after the complete eradication of COVID-19) psychological implications of experiencing a nationwide disease outbreak require further research. Third, we found that wealth levels interacted with different pandemic phases to impact psychological well-being. Although we controlled for variables (e.g., age, location) that correlate with physical health, future research can utilize more robust approaches (e.g., objective measure of one's physical health) to account for the potential influences of physical health on psychological well-being. Moreover, participants' emotional experiences in this cross-sectional investigation were captured using self-reported measures. Future research using longitudinal approaches and behavioral measures may potentially uncover further insights.

Competing interests
The authors declare no conflicts of interest.

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Contributors
JM obtained the datasets. HY and JM designed the research, analyzed the data, and wrote the manuscript.

Ethics approval
The data collection in this research received approval from the National School of Development at Peking University.

Patient and Public Involvement. Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Data availability statement
The data used in this research can be available from the corresponding author upon request.

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Table 1a. Distribution of each emotion before, during, versus after the nationwide COVID-19 outbreak in China.

	Before	**During**	**After**	χ^2	***p***
Enjoyment	79.13%	60.30%	77.59%	485.3743	<.0001
Happiness	77.34%	61.33%	76.83%	355.4037	<.0001
Laughter	69.09%	50.83%	67.35%	365.5754	<.0001
Anger	30.73%	31.90%	31.50%	2.3576	.3076
Sadness	25.54%	43.47%	28.39%	372.4647	<.0001
Stress	41.81%	59.70%	49.08%	335.4379	<.0001
Worry	27.86%	49.13%	32.85%	488.5911	<.0001
N	11131	3000	12513		

Note: The percentage of people experiencing each emotion during each pandemic phase is shown. N represents the respective final sample size.

Table 1b. Distribution of the number of positive/negative emotions experienced before, during, versus after the nationwide COVID-19 outbreak in China.

	Before	**During**	**After**
Number of Positive Emotions			
0	11.55%	28.90%	13.13%
1	10.23%	11.13%	9.67%
2	19.32%	18.57%	19.49%
3	58.90%	41.40%	57.71%
$\chi^2 = 490.8384$, $p < .0001$			
Number of Negative Emotions			
0	39.57%	26.40%	35.36%
1	22.24%	18.23%	21.66%
2	19.24%	18.27%	19.08%
3	10.61%	18.97%	13.61%
4	8.35%	18.13%	10.29%
$\chi^2 = 662.3433$, $p < .0001$			
N	11131	3000	12513

Note: The percentage of people experiencing the number of positive/negative emotions during each pandemic phase is shown.

Table 2. The relationship between wealth and emotional well-being before, during, versus after the nationwide COVID-19 outbreak in China.

Overall Emotional Well-being							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
During	-.323****	-.301****	-.303****	-.182****	-.180****	-.170****	-.171****
	(.012)	(.022)	(.021)	(.035)	(.035)	(.037)	(.037)
After	-.052****	-.080****	-.065****	-.054***	-.046*	-.064***	-.064***
	(.008)	(.012)	(.012)	(.018)	(.019)	(.020)	(.020)
Income		.019****	.013****		.019****	.013****	.012****
		(.004)	(.004)		(.002)	(.004)	(.004)
Income × During		-.011	-.014			-.007	-.008
		(.011)	(.011)			(.011)	(.011)
Income × After		.017****	.014***			.014**	.014***
		(.005)	(.005)			(.005)	(.005)
Real Estate Ownership			.195****	.220****	.206****	.216****	.210****
			(.010)	(.015)	(.016)	(.016)	(.016)
Real Estate Ownership × During				-.166****	-.163****	-.165****	-.161****
				(.037)	(.037)	(.037)	(.037)
Real Estate Ownership × After				.018	.010	.001	.0006
				(.020)	(.021)	(.021)	(.021)
Hubei			-.007		-.004		-.005
			(.017)		(.017)		(.017)
Age			.0004		.0004		.0004
			(.0003)		(.0003)		(.0003)
Sex			.005		.005		.005
			(.007)		(.007)		(.007)
Married			.007		.006		.006
			(.010)		(.010)		(.010)
N	26644	26009	26009	26644	26009	26009	26009
Constant	.437****	.403****	.224****	.249****	.206****	.229****	.215****
	(.005)	(.009)	(.015)	(.014)	(.018)	(.015)	(.018)

Notes: † $p \leqslant .10$; * $p \leqslant .05$; ** $p \leqslant .01$; *** $p \leqslant .005$; **** $p \leqslant .001$
Standard errors are shown in parentheses below coefficient estimates. Dummy variable coding: During (1 = during the nationwide COVID outbreak, 0 = other time period), After (1 = after the nationwide COVID outbreak had been contained and the economy reopened, 0 = other time period), Real Estate Ownership (1 = owner, 0 = non-owner), Hubei (1 = in Hubei, 0 = not in Hubei), Sex (1 = female, 0 = male), and Married (1 = married, 0 = not married). (Zero values on the During and After dummies represent the before pandemic condition, which serves as the reference group in the analyses.) N represents the sample size of the respective analysis.

Table 3. The relationship between wealth and positive emotions before, during, versus after the nationwide COVID-19 outbreak in China.

Positive Emotion Index							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
During	-.177****	-.181****	-.187****	-.120****	-.115****	-.124****	-.122****
	(.007)	(.014)	(.014)	(.022)	(.022)	(.024)	(.024)
After	-.013**	-.023***	-.018*	.003	.004	-.003	-.003
	(.005)	(.007)	(.007)	(.012)	(.012)	(.013)	(.013)
Income		.010****	.007***		.010****	.007***	.007***
		(.002)	(.002)		(.001)	(.002)	(.002)
Income × During		.004	.002			.006	.005
		(.007)	(.007)			(.007)	(.007)
Income × After		.005†	.005			.005	.005†
		(.003)	(.003)			(.003)	(.003)
Real Estate Ownership			.071****	.081****	.086****	.080****	.088****
			(.007)	(.010)	(.010)	(.010)	(.010)
Real Estate Ownership × During				-.067***	-.076***	-.071***	-.079****
				(.023)	(.023)	(.023)	(.023)
Real Estate Ownership × After				-.014	-.015	-.019	-.018
				(.013)	(.013)	(.013)	(.013)
Hubei			-.002		-.001		-.002
			(.010)		(.010)		(.010)
Age			-.001****		-.001****		-.001****
			(.0002)		(.0002)		(.0002)
Sex			.033****		.033****		.034****
			(.004)		(.004)		(.004)
Married			.020***		.020***		.020***
			(.006)		(.006)		(.006)
N	26644	26009	26009	26644	26009	26009	26009
Constant	.752****	.734****	.697****	.683****	.680****	.670****	.685****
	(.003)	(.006)	(.009)	(.009)	(.011)	(.010)	(.011)

Note: † $p \leqslant .10$; * $p \leqslant .05$; ** $p \leqslant .01$; *** $p \leqslant .005$; **** $p \leqslant .001$

Table 4. The relationship between wealth and negative emotions before, during, versus after the nationwide COVID-19 outbreak in China.

Negative Emotion Index							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
During	.146****	.120****	.117****	.062***	.065***	.046*	.049*
	(.007)	(.013)	(.012)	(.020)	(.020)	(.022)	(.022)
After	.040****	.057****	.047****	.057****	.050****	.061****	.061****
	(.004)	(.007)	(.007)	(.011)	(.011)	(.012)	(.012)
Income		-.009****	-.005**		-.009****	-.005*	-.006**
		(.002)	(.002)		(.001)	(.002)	(.002)
Income × During		.015*	.016**			.013*	.013*
		(.006)	(.006)			(.006)	(.006)
Income × After		-.012****	-.009***			-.009***	-.008***
		(.003)	(.003)			(.003)	(.003)
Real Estate Ownership			-.124****	-.139****	-.120****	-.136****	-.122****
			(.006)	(.009)	(.009)	(.009)	(.009)
Real Estate Ownership × During				.099****	.087****	.093****	.082****
				(.021)	(.021)	(.022)	(.022)
Real Estate Ownership × After				-.032**	-.025*	-.020	-.019
				(.012)	(.012)	(.012)	(.012)
Hubei			.005		.003		.004
			(.010)		(.010)		(.010)
Age			-.002****		-.002****		-.002****
			(.0002)		(.0002)		(.0002)
Sex			.029****		.029****		.028****
			(.004)		(.004)		(.004)
Married			.013*		.014*		.014*
			(.006)		(.006)		(.006)
N	26644	26009	26009	26644	26009	26009	26009
Constant	.315****	.331****	.473****	.434****	.475****	.441****	.470****
	(.003)	(.005)	(.009)	(.008)	(.010)	(.009)	(.010)

Notes: † $p \leqslant .10$; * $p \leqslant .05$; ** $p \leqslant .01$; *** $p \leqslant .005$; **** $p \leqslant .001$

Figure 1. The relationship between income and emotional well-being before, during, versus after the nationwide COVID-19 outbreak. X-axis represents household income (in RMB 10,000 increments). Y-axis represents emotional well-being. The panels are, respectively, overall emotional well-being index (EWB), positive emotion index (PE), negative emotion index (NE), Happiness, Smile/Laughter, Enjoyment, Sadness, Worry, Stress, and Anger. Blue line represents the period before the nationwide coronavirus outbreak; red line, during the outbreak; yellow line, after the nationwide outbreak. Shaded areas represent the 95% CI for the respective line.

Figure 2. The relationship between real estate ownership and emotional well-being before, during, versus after the nationwide COVID-19 outbreak. X-axis represents the three time periods: before, during, versus after the nationwide coronavirus outbreak. Y-axis represents emotional well-being. Orange line represents real estate owners; gray line, non-owners.

Figure 3. The relationship between income and emotional well-being before versus after the nationwide COVID-19 outbreak. X-axis represents household income (in RMB 10,000 increments). Y-axis represents emotional well-being. Blue line represents the period before the nationwide coronavirus outbreak; yellow line, after the nationwide outbreak. Shaded areas represent the 95% CI for the respective line. The gray area represents the Johnson–Neyman regions of significance. The area between the two dashed lines represent the region of non-significance. Specifically, those with an income higher than the dash line on the right, experienced significantly better overall emotional well-being after the outbreak had been contained than prior to the outbreak. In contrast, those with an income lower than the dash line on the left, were significantly worse off after the end of the nationwide outbreak than before the outbreak began.

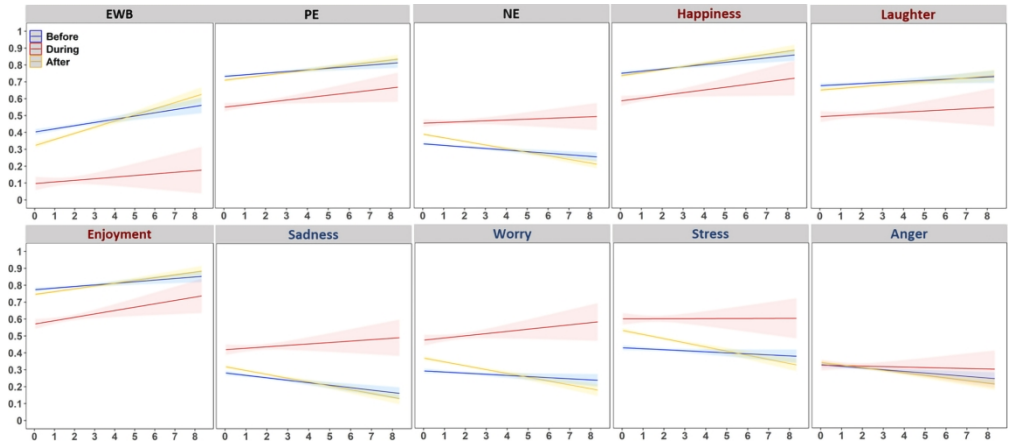

Figure 1. The relationship between income and emotional well-being before, during, versus after the nationwide COVID-19 outbreak. X-axis represents household income (in RMB 10,000 increments). Y-axis represents emotional well-being. The panels are, respectively, overall emotional well-being index (EWB), positive emotion index (PE), negative emotion index (NE), Happiness, Smile/Laughter, Enjoyment, Sadness, Worry, Stress, and Anger. Blue line represents the period before the nationwide coronavirus outbreak; red line, during the outbreak; yellow line, after the nationwide outbreak. Shaded areas represent the 95% CI for the respective line.

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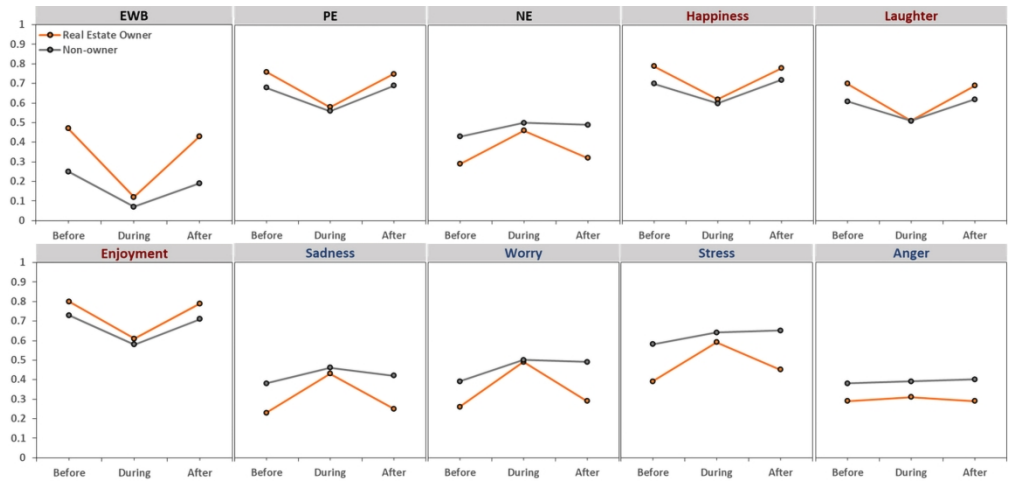

Figure 2. The relationship between real estate ownership and emotional well-being before, during, versus after the nationwide COVID-19 outbreak. X-axis represents the three time periods: before, during, versus after the nationwide coronavirus outbreak. Y-axis represents emotional well-being. Orange line represents real estate owners; gray line, non-owners.

209x99mm (300 x 300 DPI)

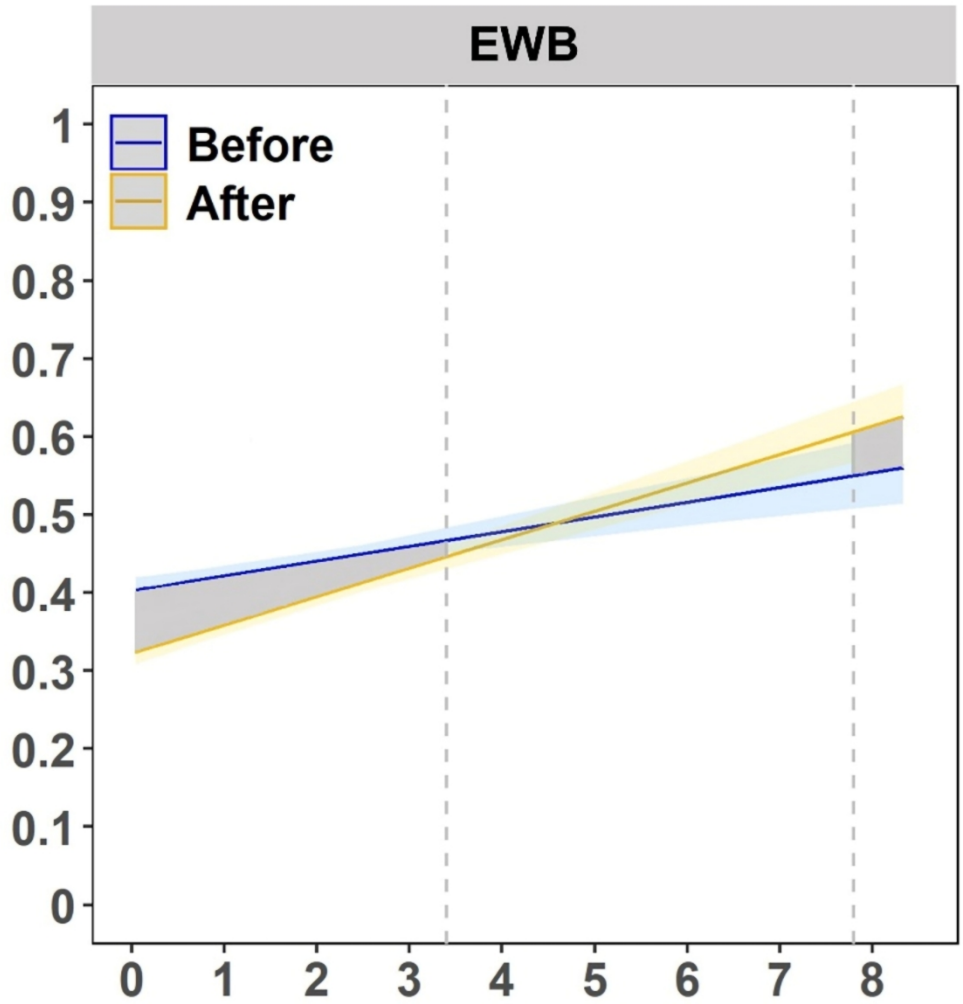

Figure 3. The relationship between income and emotional well-being before versus after the nationwide COVID-19 outbreak. X-axis represents household income (in RMB 10,000 increments). Y-axis represents emotional well-being. Blue line represents the period before the nationwide coronavirus outbreak; yellow line, after the nationwide outbreak. Shaded areas represent the 95% CI for the respective line. The gray area represents the Johnson–Neyman regions of significance. The area between the two dashed lines represent the region of non-significance. Specifically, those with an income higher than the dash line on the right, experienced significantly better overall emotional well-being after the outbreak had been contained than prior to the outbreak. In contrast, those with an income lower than the dash line on the left, were significantly worse off after the end of the nationwide outbreak than before the outbreak began.

260x274mm (300 x 300 DPI)